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ABSTRACT

This teacher's guide offers background information that teachers can use to incorporate topics related to agriculture and the environment into the curriculum. Classroom activities to bring these topics alive for students in grades 6-9 are suggested. Chapters include: (1) Pesticides and Integrated Pest Management; (2) Food Safety; (3) Water Quality; (4) Understanding Wetlands; and (5) Endangered Species. Contains 44 references. (WRM)

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TEACHER'S GUIDE

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Agriculture **the Environment**

Publisher: American Farm Bureau
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The guidebook offers background information that teachers can use to incorporate topics related to agriculture and the environment into the curriculum. Classroom activities are suggested as ways to bring these topics alive for students in grades 6-9. The material was written by Linda Maston McMurry, an award winning teacher with more than 17 years of experience teaching middle school science in Texas. She received the Governor's Award for Environmental Excellence in 1994 for work she and her students did with indoor air quality. Linda and her students have been featured in magazine articles published in WIRED, Science World, Technology and Learning, and Science, as well as on National Public Radio. She has been a workshop presenter at the National Science Teachers Association conference for the past ten years. All information was reviewed by American Farm Bureau Federation public policy specialists Herb Manning, Don Parrish, Jim Porterfield and Scott Rawlins.

For information about other classroom resources for agricultural education, check our website (www.agfoundation.org) or contact: Foundation for Agriculture, 225 Touhy Avenue, Park Ridge, IL 60068. Phone: 847-685-8663 Fax: 847-685-8626. E-mail: lauriew@fb.com

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Pesticides and Integrated Pest

From dandelions in our lawn, or a wasp nest on the front porch, to caterpillars chewing up our tomato plants, a mouse invading our pantry, or a line of ants marching toward the open jelly jar we forgot to put away — each of us has confronted pest problems. Often, the first response is to apply a pesticide. Sometimes we apply pesticides to prevent invasions by pests. Most of us do not think twice about using these products.

While the overuse of pesticides can lead to environmental damage and health hazards, the availability of pesticides has improved our lives. Because of pesticides, food production per acre has gone up, the variety of foods has increased, certain diseases have been controlled, and our quality of life has continued to improve. Without pesticides, we would pay higher prices for food that would invariably show signs of damage by insects or other pests. In addition, we would be forced to divert land into food production that is being set aside as forests, wetlands, and wildlife habitat. The land itself would suffer as we began to cultivate soils of marginal fertility.

What is a Pesticide?

The word pesticide is a generic term that refers to products meant to kill or control the entire spectrum of organisms that people consider to be pests. The specific categories of pesticides are:

1. Insecticides for insects
2. Herbicides for plants
3. Rodenticides for rodents
4. Nematocides for nematodes
5. Fungicides for fungi
6. Arachnicides for spiders, mites, ticks

Some pesticides are formulated to be effective on specific pests while others are useful for a broad spectrum of pests and therefore are multi-purpose.

Access to Pesticides

Farmers, ranchers, landscaping services, pest control services, and others engaged in commercial use of pesticides must be trained and licensed, or certified, to apply pesticides. Annual continuing education courses are required in order for pesticide applicators to maintain their certification. Stringent regulations exist to control how pesticides must be mixed, stored and disposed of.

Relatively few pesticides are licensed for "restricted use only" by certified applicators. The vast majority of pesticides are available to everyone. The primary difference in the pesticides homeowners use and those that commercial applicators use is the size of the container. The concentrations available remain the same. Unfortunately, a lot of homeowners mistakenly believe that if a little is good, then twice as much is twice as good. Consequently, the average homeowner uses eight times the amount of pesticide per acre as the average farmer.

The average homeowner is also less likely to know how to properly dispose of excess product. Too often, remaining pesticides and containers are put out for regular trash pick-up, or residues are poured down a drain into the sewage system. Municipal sewage treatment systems generally are not designed to remove pesticides, so these untreated contaminants become part of non-point-source pollution.

Farming Practices Reduce Pesticide Use

When incorporated into certain farming practices, pesticides can actually benefit the environment. For example, soil erosion has been drastically reduced with the introduction of conservation tillage. Conservation tillage, or no-till, means that farmers do not have to mechanically till their fields to get rid of weeds. Instead, they leave crop stubble and dead grass in between the crop rows and apply herbicide to kill the weeds that would otherwise rob a crop of moisture and nutrients. This practice allows farmers to reduce soil erosion, as well as reducing fuel consumption and associated costs.

Management

Although herbicide use has gone up with expanded use of no-till, overall pesticide use in the United States continues to go down each year. In part, this is because of safer, more effective pesticides that can be used in smaller amounts. In addition, the development of pest resistant plant varieties has enabled farmers to control certain pests with less pesticide. Pesticides represent a sizeable investment; farmers do not want to use more than is absolutely necessary. The ability to use fewer applications and smaller amounts of pesticides means increased profit for farmers.

Global positioning system (GPS) units make use of computer technology linked to satellites to determine precise field locations where control is needed, and to regulate the amounts of pesticides delivered in a more efficient manner than was previously possible.

Integrated Pest Management Offers Multiple Strategies

Another reason for reduced pesticide use in agriculture is the increased adoption of integrated pest management, or IPM. IPM is a systems approach to pest management that integrates the use of chemicals with cultural, mechanical, and biological control methods to minimize pest damage. The goal of IPM is not to completely eradicate pests, but rather to control pest populations in order to prevent both the pests and the pest management activities from having an adverse affect upon both crops and the environment. The methods of doing this vary among crops and among regions of the country.

IPM is not an anti-pesticide program. But pesticide application is only one technique, and one that is used only when pest numbers exceed a tolerable limit. IPM involves selective use of pesticides designed specifically for an intended pest, and only in amounts necessary, since overuse can cause insects to build up resistance to pesticides.

Healthy plants can withstand a surprisingly large number of insect pests. In an IPM program, both the pest populations and the beneficial populations are monitored. Naturally occurring organisms such as ladybugs, preying mantises, and lacewing larvae frequently prevent pest populations from reaching damaging levels. Birds are also an effective biological control.

A successful IPM program also uses cultural controls such as uniform planting and plow-up dates to prevent pests from moving from field to field. Planting crops before insects become active and using seeds that are pest-resistant and faster maturing enable farmers to harvest before pests become too abundant. The use of intermixed plantings can help control pests by attracting beneficial insects or by attracting pests away from one crop into other plantings. Planting alfalfa strips next to cotton is one example of this approach.

Pheromone traps can be used to trap insects, or keep them from mating. These traps are also useful in determining the kinds and numbers of insects in a field. Commercially available insect

pathogens can also be employed to kill certain pests but spare beneficial species. Nets, reflective mulches, and planting distance from roads are other means of mechanically controlling the movement of pests into a field. Together, these integrated pest management practices attempt to create favorable growing conditions for plants and unfavorable conditions for pests.

New Generation of Pesticides

The pesticides used today are more effective in smaller amounts, and they break down faster in the environment than those used 30 years ago. One of the best examples is glyphosate (Roundup), a broad-spectrum herbicide used to kill a wide variety of unwanted plants with no effect on birds, animals, or other wildlife. Because glyphosate is a compound that breaks down in the soil and does not accumulate in the environment or the food chain, it is highly attractive to farmers because it allows them to rotate their crops. But because glyphosate does not distinguish between weeds and crop plants, researchers have developed several crop varieties that are resistant to glyphosate. This allows farmers to use one of the safest herbicides available to kill weeds in their fields without any danger to their crops.

Pesticides and Groundwater

Atrazine is one of the most common herbicides used to control weeds and, at the same time, prevent soil erosion. It is used only during three months of the year and is applied to a field once during the growing season. Not surprisingly, atrazine is one of the herbicides that frequently shows up in ground water supplies. But is it dangerous? It has been safely used for over 30 years without being linked to any form of cancer. Atrazine breaks down quickly in the environment, leaving no by-products to build up from year to year. Recent testing has shown that it is 10 times safer than previously thought.

The EPA has raised the No Effect level for atrazine from 3 ppb, to 20 ppb. Using those levels, a person would have to drink 22,000 gallons of water per day to reach the No Effect level of 3 ppb, and 154,000 gallons of water a day to reach the new 20 ppb No Effect level. According the 1991 National Pesticide Survey, less than 1 percent of either rural domestic wells or community water system wells contain any pesticides, even seasonally, above the life-time health advisories. So, although there is a chance that pesticides are present in our drinking water, they certainly are not present at levels that pose any real risks to our health and to the environment.

Basic Understandings

The following statements taken from the previous section represent basic understandings that teachers can incorporate into learning objectives for a unit on this subject.

1. Pesticide is a generic term referring to anything used to kill or control pests. Specific forms of pesticides are herbicides, insecticides, fungicides, rodenticides, nematocides, and arachnides.
2. Anyone who applies a pesticide commercially must be trained and certified to apply pesticides. Annual re-training to maintain certification is required.
3. Except for a very few "restricted use" pesticides, anyone can buy and use pesticides.
4. The main difference between pesticides used by the general public and those used by commercial applicators is the size of the container, not the concentrations available.
5. The average homeowner uses eight times more pesticides per acre than the average farmer.
6. The use of pesticides enables us to grow more food, at a higher quality and at a reasonable cost, on less land.
7. Without pesticides it would be necessary to use more land for agriculture, thereby reducing the land available for wildlife habitat.
8. IPM does not attempt to completely eradicate pests, but to keep them at acceptable levels. Healthy plants can withstand large numbers of pests without adverse effects.
9. Monitoring the proportion of beneficial insects compared to harmful insects is a vital part of IPM. Ladybugs, praying mantises, and other insects help to control pests.
10. Pesticides are carefully chosen to target only specific pests and used only in amounts sufficient to eradicate the infestation, in order to prevent environmental damage as well as increased insect tolerance.
11. Cultural, biological, and chemical controls are all important components of IPM.
12. Soil erosion in the United States has been drastically reduced by using herbicides to control weeds in no-till and conservation tillage farming.
13. Newer, safer pesticides that break down quickly in the environment and are effective in much smaller doses are constantly replacing older, less effective and less safe ones.
14. Plant varieties that are resistant to certain pests enable farmers to use less pesticide.
15. Glyphosate (Roundup) is one of the safest, broad-spectrum herbicides available. It does not harm birds, animals, or other wildlife. It also breaks down very quickly in the environment and poses no risk to humans.
16. Plant varieties that are resistant to glyphosate enable farmers to control weeds with one of the most environmentally safe herbicides without damaging their crops.
17. Atrazine, one of the major pesticides being detected in drinking water, has been used safely for over 30 years and is not linked to any risk of cancer.
18. Atrazine breaks down quickly in the environment and leaves no residual by-products to build up from year to year. Atrazine is applied to a field only once during the approximately three-month growing season.
19. The EPA has raised the No Effects level for atrazine from 3 ppb (parts per billion) to 20 ppb. In order to get 20 ppb, it would be necessary to drink 154,000 gallons of water a day.
20. According to the 1991 National Pesticide Survey, less than 1 percent of either rural domestic wells or community water system wells contain any pesticides, even seasonally, above the life-time health advisories.

Activity:

Dilution Solution

Pesticides today are nothing like they were 30 years ago. They are increasingly effective in much smaller amounts, are not nearly the health hazard that they once were, and are much more friendly to the environment. They are also increasingly expensive. All of this means that a farmer is not going to use any more than is absolutely necessary to control a pest. As a general rule, the amount of pesticide farmers use is equal to spreading a pint of water evenly over a football field. In this activity, the learner will attempt to spread a small amount of vinegar evenly over a surface area in much the same way a farmer would spread a pesticide over a field.

Materials

Vinegar, pH paper, 25 mL distilled water, spray bottle, eye dropper, safety goggles, table top, paper towels or newspapers to cover surface of lab table. (Note: a syringe used for allergy shots or insulin injections can also be used to accurately measure out the vinegar)

Procedure

1. Wearing safety goggles, test the pH of the vinegar and record it in the table below.
2. Test the pH of the distilled water and record it in the table below.
3. Pour 25 mL of distilled water into the spray bottle. Measure out 0.05 mL of vinegar and add it to the distilled water. Cap and shake to mix.
4. Test the pH of the mixture and record it in the table below.
5. Cover your lab table with the paper towels or newspapers. Spray the vinegar/water solution evenly over the surface of the lab table.

Liquid	pH
vinegar	
distilled water	
vinegar/distilled water	

Learning Objectives

After completing the activity the learner should be able to explain why:

- Detection of a substance does not necessarily mean it is harmful.
- Pesticides can be used in such small amounts.
- Pesticides benefit people and the environment.

Summary Questions

1. The pH of the vinegar/water solution was most like the pH of (the vinegar), (the distilled water), (somewhere in between).
2. How is trying to spread the 0.05 mL of vinegar evenly across the table similar to how a farmer spreads pesticide on a field? How is it different?
3. Most accidents with pesticides happen during the mixing and transfer stage. Why do you think this happens? What could be done to help prevent it from happening?
4. Explain the role technology plays in reducing pesticide use.
5. Why does the detection of a pesticide in drinking water not automatically mean the water is unsafe to drink?

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Food Safety

Juicy red apples, crisp green heads of lettuce, large golden ears of corn, crunchy orange carrots — all free from signs of disease, decay, or insect damage. This is what we look for when shopping for produce. Few of us think about why we are able to buy food of this quality, or why we can do it all year round, and at a reasonable price. The reason we can do this is because of modern agriculture practices, such as the use of pesticides.

Natural and Synthetic Pesticides

We naturally assume that the foods we buy — whether fresh, frozen, or canned — are safe to eat. Yet, recent news stories have presented information about pesticide residues in fruits and vegetables and the possible risk of cancer they pose to our health. Should we be concerned? The consensus among medical experts is that there is a greater risk of getting cancer and other diseases by not eating fresh fruits and vegetables than that from consuming minute amounts of pesticides.

When thinking about pesticides and food safety, it is important to consider several factors:

- The sophistication of modern detection methods
- The new generation of synthetic pesticides
- Naturally occurring plant pesticides
- Consequences of not using pesticides

Today, we are able to detect levels of contaminants in parts per billion (ppb) that were undetectable just a few years ago. As technology continues to improve, we may routinely detect amounts as small as one part per trillion, or one part per quadrillion. So how do pesticides at these levels affect us? Essentially, we are unable to eat or drink enough of a product to be affected by pesticides present at parts per billion and lower levels.

The nature of manufactured pesticides has changed dramatically over the last 30 years. The new pesticides break down faster in the environment, are effective in smaller doses (often at ounces per acre rather than pounds per acre), and are targeted to be harmful only to specific organisms. For example, a compound called glyphosate (found in Roundup herbicide) works by interfering with plant photosynthesis. Because insects, birds, and people do not carry on photosynthesis, it has no serious effect upon them. And glyphosate is degraded by microorganisms found in the soil, so it does not accumulate in the environment.

Most plants naturally produce chemicals that act like pesticides. By weight, we ingest at least 10,000 times more of these natural pesticides than residues of manufactured pesticide. And chemicals are chemicals, whether they are naturally-occurring or manufactured.

Finally, we need to consider the possible consequences of not using pesticides. To protect our food crops, farmers and ranchers around the world must compete with approximately one million insect species, a thousand species of harmful nematodes, hundreds of weed species, and enough varieties of fungi to cause 1,500 plant diseases. Without pesticides to control molds, much of our food supply would rot and consumer health would be at risk, since molds in high enough concentrations can be lethal. For example, without the use of pesticides to control fungi, celery would produce its own natural pesticides, called psoralens, which can cause a severe skin

"To sell nothing except foods untreated by pesticides would not only leave storekeepers with rotting food, but would also fail to protect the consumer against molds that in high enough concentration can be lethal. People who are so worried about pesticides fail to realize that the cancer rates have dropped over the past 40 years."

C. Everett Koop, MD
Former U.S. Surgeon General

reaction in humans. The use of a fungicide prevents this from happening.

Regulating Food Product Safety

Pesticides are regulated by federal and state government agencies. At the federal level, pesticides are regulated by the Environmental Protection Agency (EPA) under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug and Cosmetic Act. No pesticide can be legally sold or used in the United States unless its label bears an EPA registration number and establishment number. The EPA approves a pesticide only for specific uses. The label tells where and how the pesticide may be used. A number of pesticides are labeled as "restricted use" pesticides, and only certified applicators may use these products.

Before being registered, pesticides are subject to extensive testing to insure that, when used properly, they will not present unreasonable risks to human health or to the environment. The EPA calculates safe, lifetime human exposure levels called the Acceptable Daily Intake, or ADI.

These safe levels are determined by using the most sensitive laboratory animal species — usually rats — to find the No Observable Adverse Effect Level, or NOAEL, and dividing it by 100 or 1,000 in order to provide a margin of safety for children, the elderly, or especially sensitive individuals.

Using worst-case levels seemed to be the sensible approach to product safety when the government first began testing pesticides. Given how much our level of scientific knowledge has changed, these methods still being used by the EPA are believed by many scientists to be inaccurate indicators of product safety.

Food Safety and the Delaney Clause

In 1958, the Delaney Clause was signed into law to protect public health by safeguarding our food supply. The Delaney Clause prohibited additives in processed foods that were shown to induce cancer in experimental animals. It allowed for zero tolerance. Any product that had a detectable amount of an ingredient known to cause cancer was banned, regardless of its potential benefits. However, at that time, scientists were able to detect substances only in parts per hundred.

"Manufactured chemicals, such as dioxin, are believed to cause less than 1% of all cancers. When people are exposed to the small amounts of such chemicals usually found in the air, water, soil and food, they have very little added risk of getting cancer."

American Institute For Cancer Research (AIRC)

Since then, the nature of pesticides and the means of detecting them have changed. We now routinely detect substances in parts per billion, and even in parts per trillion. This means that the same foods tested in 1958 and declared to be safe would today be considered contaminated merely because technology allows us to detect the presence of a mere handful of molecules.

In 1996, after years of urging and recommendations by leading scientific groups, the U.S. Congress repealed the zero-tolerance Delaney Clause and passed the Food Quality Protection Act (FQPA) to keep up with new technology. The law establishes additional safety standards for agricultural chemicals used on food crops, and requires major supermarkets to provide consumer information on the risks and benefits of agricultural chemicals and how to reduce exposure. Implementation of the FQPA provisions will take place over the next few years.

Irradiation and Food Safety

Some people get nervous at the thought of irradiated food, which they believe is radioactive and dangerous to human health. However, irradiation technology has been around for 40 years and is being used to sterilize medical supplies, surgical instruments, makeup, personal hygiene products, as well as the food eaten by astronauts and patients with compromised immune systems.

Much like pasteurization, food is irradiated to rid it of insects, parasites, and microorganisms that produce spoilage or disease. Irradiation destroys insects, fungi, parasites and bacteria such as *Salmonella*, *E. coli*, *Listeria* and *Trichinella* that cause human disease and food spoilage. Food can be kept longer, and in better condition.

Food passes through a radiation field at a set speed to control the amount of energy that passes through the food. Both the speed and the amount of radiation is computer controlled. The irradiated food is no more radioactive than your luggage is after passing through airport security, or your teeth are after an X-ray at the dentist. Irradiated food is as nutritious as food preserved by any other method, and poses absolutely no health risk. In fact, there is currently no way to detect whether or not a food was irradiated, because there are no residues to use as indicators.

Animal Product Safety

The Food and Drug Administration (FDA) is responsible for monitoring and regulating the use of animal health products. Very strict regulations exist for drugs used to treat animals and how long after treatment the farmer or rancher must wait before butchering animals, or selling their milk. These drugs also are tested to make sure they are safe for humans.

Milk production is one of the most regulated food production processes. Recently, concerns have been raised about the use of bovine somatotropin, or bST, to increase milk production. Cows

naturally produce hST, which shows up in their milk. The genetically engineered hST simply enables more efficient milk production. Tests have shown that supplemental hST does not change the amount normally found in milk, which is completely safe, natural and harmless.

The USDA makes sure that all meat processing follows strict guidelines and handling procedures to insure that the meat is not contaminated. Department of Agriculture inspectors test meat animals for more than 400 drugs, pesticides, industrial chemicals and heavy metals. Still, bacteria are present in raw meats and most of the food poisoning cases in the United States occur because of mishandled food at home, not in institutions and restaurants. Ultimately, proper hygiene and safe food handling methods are our best protection from accidental food poisoning.

Food Safety and Acceptable Risk

Risk is a part of our daily routine. We get in our cars knowing there is a risk that we might be involved in an accident. We watch toddlers take their first steps knowing there is a risk of them falling and getting hurt. We allow our children to eat grapes and peanuts even though there is a possibility they could choke to death on them.

There are certain things we can do to minimize risks. We can wear seat belts and drive defensively. We can move toddlers away from furniture with sharp edges, and keep unsafe items like electrical cords out of their way. We can encourage our children to chew their food before swallowing it, and to not talk when their mouth is full. But, even with these measures, we realize there is still a certain degree of risk. Nothing is 100% safe.

We come to believe that certain benefits far outweigh the amount of risk involved. The risks involved in food safety should be no different. Yet, sometimes, information gets distorted and it is difficult to determine exactly what the risks are. Misinformation occasionally causes products to be taken off the market when there is no reason to do so. For example:

1. Cyclamates and saccharine, both artificial sweeteners, were banned even though in the case of saccharine, a person would have to drink over 800 cans of soft drinks a day for years to reach the point where they might risk getting cancer. The public uproar over saccharine has kept it on the market despite the fact that the FDA has ordered it to be re-tested and has restricted its use to that of a controlled, over-the-counter table-top sweetener. Cyclamates on the other hand still have not regained approval.
2. Alar, a growth regulator used on apples to keep them from dropping off the tree too early, was removed from the market because of a media scare that linked it to cancer in children. However, a child would have to eat 28,000 pounds of alar-treated apples daily for 70 years in order to cause any tumors at all to occur.

3. Atrazine, a popular herbicide, is frequently detected in ground water supplies, particularly in the Midwest during the approximately three month growing season, when farmers apply a one-time application to their fields. But the levels detected, even during times of peak usage, are so low that a person would have to drink 154,000 gallons of water a day just to reach the EPA's No Effect level of 20 parts per billion. Yet, there is a move to ban atrazine.

We have the right to expect that the food we buy is safe to eat, and our water safe to drink. But we also need to realize that nothing is ever going to be guaranteed 100% risk-free. We need to weigh the benefits against the risks and decide if the risk is acceptable. If we do this we will find that our food supply is one of the safest in the world. And while there are certainly risks involved, they do not come from the pesticides, chemicals, or technologies used to produce them.

Basic Understandings

The following statements represent basic understandings about food safety to be mastered by learners. These statements can be used in devising learning objectives, classroom activities and test items for a module on food safety.

1. The quality and abundance of our food supply is due to modern agricultural practices which include the use of pesticides.
2. A pesticide is a generic term used to refer to substances used to kill or control pests.
3. Most plants are capable of producing their own natural pesticides. We ingest at least 10,000 times more of these natural pesticides, by weight, than we do of synthetic pesticide.
4. Chemicals are chemicals, whether they are naturally-occurring or manufactured.
5. Detection alone does not mean contamination. We are now able to routinely detect amounts in parts per billion (ppb). This means we can now detect things we previously could not.
6. One part per billion is the same as 1 second in 32 years, or 1 cent in \$10 million.
7. One part per trillion is the same as 1 second in 32,000 years, or 1 cent in \$10 billion.
8. Manufactured pesticides have changed over the last 30 years. They are increasingly less toxic, break down faster in the environment, are effective in much smaller amounts, and are more likely to be harmful only to specific organisms.
9. At the federal level, pesticides are regulated by the Environmental Protection Agency under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug and Cosmetic Act. No pesticide can be legally sold or used in the United States unless its label bears an EPA registration number and establishment number.

"The cancer risk for children from eating fruits and vegetables as it relates to pesticides is very, very small. The benefits that you get from eating fruits and vegetables far outweigh any risk from pesticide residue in vegetables and fruits."

Dan Nixon, MD, PhD
American Cancer Society

"Epidemiologic reports of the past decade reinforce the conclusion that fruit and vegetable consumption is linked to reduced cancer risk. The levels of synthetic pesticide residues in food seem so low as to be of no consequence whatever."

American Medical Association

10. Pesticides are subject to extensive testing before being registered to insure that when used properly they will not present unreasonable risks to human health or the environment.
11. The EPA calculates safe, life-long human exposure limits using the most sensitive laboratory animal species through a process resulting in the No Observable Adverse Effect Level, or NOAEL.
12. The EPA calculates a safe, daily exposure level for humans called the Acceptable Daily Intake, or ADI. This is done by taking the NOAEL amount and converting it to humans, providing an additional margin of safety for children, the elderly, and especially sensitive individuals.
13. Carcinogens or other natural toxins are present in foods such as beans, lettuce, apples, celery, strawberries, beets, spinach, cabbage, carrots, radishes, onions, oranges, bananas, as well as many others.
14. The Delaney Clause, enacted in 1958, prohibited any additive in processed foods that had been shown to cause cancer in laboratory animals. The law did not distinguish between natural and synthetic substances.
15. Because the Delaney Clause was never updated to take into account improved detection methods, the same foods previously considered safe in 1958, today could legally be declared contaminated.
16. Over 99.99% of the carcinogenic substances we consume in our diet are naturally occurring defense mechanisms produced by the plants themselves.
17. Much like pasteurization, food is irradiated to make it safer and more resistant to spoilage. Irradiation destroys insects, fungi, parasites and bacteria such as *Salmonella*, *E. coli*, *Listeria* and *Trichinella* that cause human disease, or cause food to spoil.
18. Irradiation does not make food radioactive and leaves no residues, so it is currently impossible to detect whether or not a food has been irradiated.
19. Irradiation does not decrease the nutritional value of food any more than other food preservation methods.
20. Irradiation does not harm the environment, uses relatively low amounts of energy, produces little heat, and no radioactive byproducts that could accidentally be released into the environment.
21. Cows naturally produce bovine somatotropin, or bST, which shows up in their milk. Genetically engineered bST simply enables more efficient milk production. This supplemental bST does not change the amount naturally found in milk.
22. There is no such thing as zero-risk. Although there are things we can do to minimize risk, risk is a part of our daily routine, and nothing is ever going to be 100% risk-free.
23. Acceptable risk is where the benefits far outweigh the risk involved.
24. Saccharine, an artificial sweetener, was banned even though a person would have to drink more than 800 cans of soda every day for years to develop a risk of cancer. It has been approved only as a regulated, over-the-counter table-top sweetener.
25. A media scare caused alar, a growth regulator for apples, to be removed from the market despite evidence that it did not cause cancer in children even in doses equal to 28,000 pounds of apples per day.
26. Atrazine is a herbicide found in some drinking water supplies in such minute concentrations that a person would have to drink 154,000 gallons of water every day in order to reach even the No Effect Level of 20 ppb.
27. Proper hygiene and safe food handling methods are our best protection from accidental food poisoning.
28. The food supply in the United States is generally recognized as the safest in the world.
29. Experts agree that a diet rich in fruits and vegetables is still our best defense against cancer.

Activity:

Giving Plants The "Rat Test"

Before the EPA approves a substance it is tested extensively on rats. These rats are either force-fed or injected with the substance at a level thousands of times higher than a human could possibly consume. This means that, at a high enough dose, even the safest substances will cause death or cancer in rats. These test results are then applied to humans and many otherwise safe products are removed from the market, or never approved in the first place. Saccharine, cyclamates, and alar are three examples.

Materials

6-9 plants, all the same kind (consult the Living Science section of your Educational Service Center catalog. They should be free and come already potted), vinegar, tap water, 3 watering containers, data sheet for recording observations.

Procedure

1. Divide the plants into three groups and label each group.
2. Each plant in Group A is to be "watered" with 50 mL of pure vinegar daily.
3. Each plant in Group B is to be "watered" daily with 50 mL of tap water to which one drop (or .05 mL) of vinegar has been added.
4. Group C is the control group. Each plant will receive 50 mL of tap water daily with NO vinegar added.
5. Make sure conditions for all three groups of plants are the same with the exception of what they are watered with. Keep the watering containers used for each group separate and marked so as to not accidentally use a contaminated watering container on a different group of plants.
6. Record the changes in the plants on a daily basis. Alternate ways that this can be done is by taking pictures, or using a video camera to record changes. Continue for two weeks.

Learning Objectives

After completing the activity the learner should be able to:

- Explain why the dose of a chemical makes the poison and not merely the presence of a chemical.
- Explain how the EPA estimates the effect of substances being tested.
- Explain why the effects to one species are not necessarily the same for another.

Summary Questions

1. The plants "watered" with vinegar (died), (showed no effect) (grew rapidly).
2. The plants "watered" with the water/vinegar mixture grew at rates similar to the plants "watered" with (vinegar), (tap water).
3. Was the small amount of vinegar harmful to the plants? (yes) (no)
4. Is watering the plants with pure vinegar a good way to estimate the type of damage that a plant would receive from a tiny amount of vinegar? Explain.
5. How would you design a better test to determine the effect vinegar in the environment might have upon plants?
6. What do you think the effects would be if you drank the same amount of vinegar as the plants were watered with on a daily basis for two weeks?
7. What can you say about the reliability of the rat tests used by the EPA?

Water Quality

Few things are more enjoyable than catching fish from a clear mountain stream, splashing around at the edge of a lake, or floating lazily down a river on a hot summer day. All of these activities depend on access to quality water supplies.

Since the Clean Water Act was passed in 1972 as the nation's primary water pollution prevention legislation, we have made great strides in cleaning up our water supplies. Yet, much of the attention has been given to easily recognized "point" sources of pollution, such as factories and sewage treatment plants. Today, attention is shifting to "non-point" sources of water pollution.

Water Pollution Categories

Sources of water pollution can be grouped into two major categories:

1. **Point-source pollution.** This type of pollution can be pinpointed directly to its source, such as a pipe discharging raw sewage or wastewater directly into a river. Regulations detailing what may be discharged, and under what conditions, have essentially taken care of flammable liquids and much of the ammonia and phosphorus water pollutants. It is important to note that, prior to the Clean Water Act and the Clean Rivers Act, these types of activities were perfectly legal.
2. **Non-point-source pollution.** We do not know the exact location and source of this pollution. Non-point-source pollution accounts for most of the water pollution in our country's rivers, lakes, streams, bays, and estuaries. Contributors to this type of pollution can be grouped into four general categories:
 - urban and industrial
 - agricultural
 - atmospheric deposition
 - natural background (eg. stream composition, wildlife)

Point-Source Pollution

Point-source pollution has been the primary focus for control efforts since the Clean Water Act was passed. This type of pollution generally comes from the millions of gallons of wastewater discharged by municipal sewage treatment plants and industrial sources. Since 1977, all industrial and municipal dischargers have been required to have both federal and state permits.

Wastewater is considered a potential source of pollution because it contains organic and inorganic materials that can be hazardous to humans and wildlife. Although some wastewater may actually be cleaner than the stream or river into which it is being discharged, it may still have adverse effects. For example, wastewater may lower the amount of dissolved oxygen in water because different organic materials require different amounts of oxygen to be broken down and stabilized in the environment. This process that breaks down waste materials is known as Biochemical Oxygen Demand, or BOD. The greater the BOD, the greater the oxygen depletion of the water.

Urban and Industrial Non-Point-Source Pollution

Rainwater typically carries contaminants such as motor oil and grease, herbicides and pesticides, household, chemicals and medical wastes. Rainwater is routed through drainage systems that usually are separate from wastewater treatment systems. And most municipal wastewater treatment facilities are not equipped to treat pesticides, herbicides, toxic household chemicals and chemotherapy wastes. Consequently, these chemicals pass unchanged through the water treatment process to be discharged in wastewater.

Any construction, particularly highway construction, can be a major source of pollution as ground cover is disturbed and the underlying soil is exposed to wind and rainfall, both of which can carry dust and dirt particles. These particles can then be either deposited by wind, or mixed with rain and deposited.

Acid rain is another source of non-point-source pollution. Power plants, industry, and exhaust from cars can contribute to acid rain. While some lakes and rivers are naturally acidic due to the underlying geology, acid rain can increase the acidity of those that are not, disrupting the aquatic ecosystems living in them.

Agricultural Non-Point-Source Pollution

Traditional agricultural practices such as irrigation, fertilizer and pesticide use, and animal manure are potential sources of pollution. With the adoption of newer conservation practices, however, these pollution problems are less likely to occur.

Confined feeding operations such as dairies or feedlots are special categories of non-point-source pollution. These types of operations are prohibited from allowing wastewater or animal waste to leave the property. All runoff must be controlled, except when excessive rainfall occurs. In these cases, it is not always possible to prevent runoff from fields, or overflow from other types of holding structures.

Few studies exist to measure the exact amounts of nutrient loading contributed by individual sources of agricultural non-point-source pollution. One such study by the U.S. Geological Survey on a ranch in south Texas indicated 204,000 pounds of fertilizers and nutrients, and 10,000 pounds of pesticides had been applied to the fields. From June 23 to June 30, 1996, 6.12 inches of rain amounting to 61,546,290 cubic feet of water fell on the ranch. Runoff amounted to 2,661,952 cubic feet. The nutrient load in this runoff was measured at 3,843 pounds. Of this, 2,284 pounds were attributable to the rain. Yet, in all this run-off, only 0.92 lb. of pesticides left the property.

Pesticides in Water

Until the late 1970s, ground water was thought to be protected from pesticide contamination by overlying layers of topsoil, subsoil, rock, and clay. By using increasingly sophisticated detection methods, we have found this belief is false. But, while pesticides may be present in our drinking water, they are not present at harmful levels. According to the 1991 National Pesticide Survey, less than 1 percent of either rural domestic wells or community water systems contain any pesticides, even seasonally, above the life-time health advisories.

The greatest health hazard from pesticide exposure occurs in the mixing and transfer of chemical concentrates, not so much in the spraying, and certainly not in the levels that are being detected in ground water.

Natural Non-Point-Source Pollution

One of the problems with controlling non-point-source pollution is the lack of information about the amounts of pollution contributed by natural sources. Nitrogen is considered to be an agricultural pollutant. Yet every thunderstorm creates several thousand pounds of nitrogen. Wildlife also adds to the nutrient loading of streams and rivers.

In addition, the underlying geology of a region can add salts, heavy metals and other toxins to water. Streams and rivers erode rocks, adding these eroded elements to the water. A National Academy of Science study indicated between 25 and 60 percent of sediment in streams is from streambank and streambed erosion. Unfortunately, these sources can be difficult to measure and few baseline studies are being done to determine exactly what effects these factors have on water quality. Better information is needed for informed decision making.

Best Management Practices Protect Water Quality

Farmers and ranchers are the original conservationists. They realize that good management of natural resources increases the value and productivity of their land. Over the years, agricultural production practices have improved in ways that benefit both the farmer and the environment by reducing pollution and, at the same time, reducing production costs. These best management practices include:

- Efforts to minimize the loss of nutrients applied to fields into surface and ground water while still maintaining the soil fertility and nutrients at levels necessary for the best crop growth.
- Integrated Pest Management (IPM), a comprehensive approach to controlling pests through cultural, biological, and chemical control systems. Pesticides are applied only when needed, which means fewer chemicals that could be lost to surface and groundwater, and substantial monetary savings for farmers.
- Manure management systems that temporarily store animal nutrients — manure, milkroom wash water, and feedlot runoff — for future application to croplands.
- Vegetative and tilling practices such as conservation tillage, contour farming, contour strip cropping, and field borders are other types of best management practices that are reducing the movement of pollutants and lessening soil erosion by wind, rain, and runoff.

All these practices are not only good for the environment because they reduce or eliminate pollution, they also conserve energy and save money.

Chemical Water Quality Indicators

Depending upon the circumstances, tests of water quality should attempt to determine the presence of heavy metals, pesticides, industrial chemicals, and various types of toxins. Water quality is affected by factors such as: temperature, pH, salinity, nitrate-nitrite, phosphorus, alkalinity, dissolved oxygen, and fecal coliform bacteria.

The amount of dissolved oxygen present is related to water temperature. Warm water holds less dissolved oxygen than cold water. Different species of fish require different dissolved oxygen levels in order to thrive. Consequently, raising the water temperature could be considered a form of pollution because it lowers the amount of dissolved oxygen in the water, which in turn can adversely affect the aquatic ecosystems of that particular body of water.

The pH level of water is determined by a number of things. Distilled water has a pH of 7, which is neutral. Normal rainfall is naturally a bit on the acidic side, with a pH of about 5.5. Depending upon the geology of the region, the water's pH may be higher or lower. Water running through rocks and soils that are of granite origin, for example, would be expected to have a pH of around 4 to 4.5. Water running through rocks and soils that are primarily of a limestone origin could be expected to have a pH of about 8 to 8.5. Over time, acid rain can change the pH of the water and have a negative affect upon the aquatic communities that are adapted to a particular range of pH.

Alkalinity is a measure of water's ability to neutralize acids. It is a fairly reliable measure of the productivity of a lake or stream. Too low an alkalinity level will not support much life, even though the water may appear nice and clear. Geology and acid rain can contribute to low alkalinity. High alkalinity levels can result from respiration in water, the underlying geology (usually limestone or dolomite), or sewage pollution.

Water needs a certain level of nutrients to be productive. Overloading it with nutrients, however, can cause problems such as algae blooms. These blooms clog the water and block sunlight from reaching the lower levels of the water column. When the algae dies, the process of decay uses up the oxygen in the water. Severe cases of oxygen depletion can result in fish-kills.

Runoff from nitrogen and phosphorus fertilizer applications and animal manure is the most frequently cited source of nutrient loading in streams, rivers, lakes, and bays. Much of this runoff comes from urban sources. The average homeowner uses *eight times* the amounts of fertilizers and other chemicals per acre as the average farmer. Septic tanks, wastewater discharges, and improperly functioning wastewater systems are other sources for high nutrient levels. It is also important to remember that nitrogen is also added through rainfall.

Phosphorus is another nutrient necessary for water productive. Unlike nitrogen, very little phosphorus enters water bodies through runoff. This is because soil particles, particularly clay, can hold on to phosphate ions. Phosphorus is also believed to be a limiting factor in the production of algal blooms regardless of the level of nitrogen and other nutrients present in water. As a result, many sewage treatment plants have special units designed to remove up to 95% of the phosphorus from wastewater.

Fecal coliform bacteria found in the digestive tract of all warm-blooded animals is relatively harmless in and of itself. However, because its presence is an indicator of other pathogens that cause infectious diseases like hepatitis and cholera, it is regulated at levels designed to prevent human illness.

Water Quality Standards

More than one set of water quality standards exists, depending on intended use. Maximum Contaminant Levels (MCLs) are the legally enforceable drinking water standards. Stricter quality standards are applied to water used for contact recreation, such as swimming, than water intended for noncontact recreation such as boating. When a water body has more than one usage, the standards applied are generally the more stringent water quality criteria.

One of the greatest problems affecting the issue of water quality is the lack of adequate data. Because water testing is time-consuming and expensive, the majority of our rivers and streams have never been adequately monitored. Much of the testing is done downstream of urban areas where a problem is more likely to exist. Consistent, long-term monitoring is required if we are going to develop an accurate, scientifically sound picture of the overall health of our nation's water.

Basic Understandings

The following statements taken from the previous section represent basic understandings that teachers can incorporate into learning objectives for a unit on this subject.

1. Point-source pollution can be attributed directly to its source, such as a pipe discharging raw or partially treated sewage or wastewater into a river.
2. Non-point-source pollution means we do not know the exact location and source of the pollution.
3. Wastewater is the most common type of point-source pollution.
4. The EPA estimates that each American household generates 20 pounds of chemical waste each year, much of which is improperly disposed of and ends up in rivers, lakes, and aquifers.
5. Sources of non-point-source pollution are classified as either urban/industrial, agricultural, atmospheric deposition, or natural background.

6. Urban and industrial sources of non-point-source pollution include runoff from streets and lawns, construction sites, and acid rain.
7. Agriculture has traditionally borne most of the blame for non-point-source pollution. Potential sources of agricultural non-point-source pollution include the irrigation of crops, applications of fertilizers and pesticides, and animal manure.
8. According to the 1991 National Pesticide Survey, less than 1 percent of either rural domestic wells or community water system wells contain any pesticides, even seasonally, above the life-time health advisories.
9. Until the late 1970s it was generally believed that ground water was protected from pesticide contamination by the overlying layers of topsoil, subsoil, rock, and clay. With increasingly sophisticated methods of detection, we now know that this is not true.
10. The greatest health hazard from pesticide exposure occurs in the mixing and transfer of chemical concentrates, not so much in the spraying, and certainly not in the levels that are being detected in ground water.
11. Natural sources of non-point-source pollution can add nutrients, heavy metals, and other toxic chemicals. Very few baseline studies exist to determine the amounts of these natural pollutants or their effects on water quality.
12. Thunderstorms add thousands of pounds of nitrogen to rainwater.
13. Wildlife also add to the nutrient and coliform loading of streams and rivers. For example, one goose produces as much fecal coliform as 10 cows.
14. Streams and rivers erode the rocks they flow through, adding salts, toxins and heavy metals to the water.
15. Farmers and ranchers are the original conservationists. They realize that good management of natural resources increases the value and productivity of their land.
16. Best management practices on agricultural lands are good for the environment because they reduce or eliminate pollution, while helping the producer conserve energy and save money.
17. Water quality is determined by a number of factors such as temperature, pH, salinity, alkalinity, nitrate-nitrite, phosphorus, dissolved oxygen, and fecal coliform bacteria.
18. The amount of dissolved oxygen present is related to water temperature. Because warm water does not hold as much dissolved oxygen as cold water, raising the water temperature could be considered a form of pollution.
19. The pH level of water is determined by a number of things. Distilled water has a pH of 7, which is neutral. Normal rainfall is naturally a bit acidic, with a pH of about 5.5.
20. Water needs a certain level of nutrients to be productive, but overloading it with nutrients can cause algae blooms that clog the water and block sunlight from reaching the lower levels of the water column.
21. When the algae dies, the process of decay uses up the oxygen in the water; severe cases of oxygen depletion can result in massive fish-kills.
22. Runoff from nitrogen-phosphorus fertilizer applications and animal manure are the sources most frequently cited as the cause of nutrient loading in streams and rivers.
23. Alkalinity is the ability of water to neutralize acids.
24. The average homeowner uses *eight times* the amounts of fertilizers and other chemicals per acre as the average farmer.
25. Fecal coliform bacteria, by itself, is a relatively harmless bacterium found in the digestive tract of all warm-blooded animals. As an indicator of other pathogens that cause infectious diseases like hepatitis and cholera, it is regulated at levels designed to prevent human illness.
26. There is more than one set of water quality standards. Maximum Contaminant Levels (MCLs) are the legally enforceable drinking water standards. Other standards of water quality are determined based upon the intended use of the water.
27. One of the greatest problems affecting the issue of water quality is the lack of adequate data. The majority of our rivers and streams have never been adequately monitored.
28. Because of a lack of consistent, long-term monitoring programs to determine water conditions across the nation, we do not have an accurate, scientifically sound picture of the overall health of our water.

Activity: **Clean It Up!**

Until the early 1970s people believed that ground water was pretty well protected from surface contamination by the layers of soil, clay, and rock overlying it. For the most part this is true. When combined with a system of agricultural best management practices such as conservation tillage, nutrient management and filter strips at the margins of production fields to prevent runoff, the ground and overlying vegetation does indeed act as a very efficient water filtering system.

With improved measuring techniques, however, we have discovered that it doesn't filter out all contaminants. We can now detect extremely minute amounts of substances that we were previously unable to. This does not necessarily have any effect on the safety of our surface and ground water, just our ability to detect impurities in it. It is the dose that makes the poison, not merely the presence of a substance. According to the EPA's 1991 study on pesticides in ground water, less than 1% of the water wells in this country had any levels of pesticides, even seasonally, that were above recommended levels.

In general, agriculture receives most of the blame for water quality problems associated with run-off. While few studies exist to measure the exact amounts of nutrient loading contributed by various individual sources of non-point-source pollution, those that do exist show resounding evidence that agricultural sources actually contribute insignificant amounts.

Materials

3 clear disposable plastic cups (per group)	kitty litter
sterile sand	food coloring
almond extract	aquarium charcoal
coffee filter	cleaned gravel
	water

Procedure

1. Fill one of the plastic cups half full of water. Add food coloring and almond extract.
2. Poke 5-8 small holes in the bottom of the second cup. Arrange any or all of the filtering materials (sand, litter, charcoal, gravel) in this cup in whichever order you think will best clean up the water sample.
3. Leave the third cup as is and use it to catch the cleaned up water supply.
4. You are in charge of water quality for your community's water system. Residents have complained that the water looks and smells "funny". Using the materials provided, determine how you will provide them with high quality drinking water and also convince them it is safe to drink.

Learning Objectives

After completing the activity the learner should be able to explain:

- Reasons for water quality degradation.
- Challenges in determining water quality standards.
- How best management practices that use natural filtering properties of plants, soil, clay, and rock can protect water quality.

Summary Questions

1. What materials did you use to clean up your water sample?
2. Did the order that you used them make a difference to the end result?
3. Were you successful in cleaning up your water sample?
4. How did you decide that the water was or was not clean?
5. What criteria did you use to determine that the water was safe to drink?
6. Given what you know about what it takes to clean up water, suggest some best management practices that might prevent, or at least reduce to negligible levels, any water pollution.
7. How would you encourage the implementation of these practices without resorting to only punitive measures?

Understanding Wetlands

Throughout much of our history, wetlands were considered dangerous, unhealthy, insect and disease infested places with no economic value. Many programs actively supported and encouraged people to fill and develop these lands. As a result, nearly 54 percent (about 100 million acres) of our original wetlands have been destroyed or converted to other uses.

Recently, we have come to recognize that wetlands are important and productive ecosystems. They not only provide products for human use — including clothing and food — but also help to recharge ground water, purify polluted waters, provide habitat for wildlife, protect from flooding, and offer recreational settings.

What Is A Wetland?

Wetlands are transitional zones between aquatic environments and terrestrial environments. The term wetland covers a variety of wet environments. Each wetland is a little different and not all wetlands have equal value. Swamps, bogs, coastal and inland marshes, wet meadows, potholes, playas, mudflats, ponds, and bottomland hardwood forests are all types of wetlands. Wetlands occur in both freshwater and saltwater systems on every continent, except Antarctica, and in every climate from the tropics to the tundra.

It is sometimes difficult to pinpoint exactly what is a wetland, and what is merely wet land. For legal purposes wetlands are defined as lands that meet three criteria:

1. They are saturated by surface or groundwater for at least part of the growing season.
2. Under normal conditions they support hydrophilic vegetation (plants adapted to live in wet environments).
3. They have hydric soils (soils that develop under anaerobic, or low-oxygen, conditions).

Although some 75 percent of U.S. wetlands are privately owned, federal policies exist that govern their use. Until now, wetlands policy has been constructed by the courts and by regulatory agencies and is subject to varying interpretations at the local level.

Types of Wetlands

Differences in climate result in different types of wetlands found in particular areas. Despite the many individual and regional variations, wetlands can be grouped into the following general categories.

Gulf Coast Salt and Brackish Marshes. This type makes up about 80 percent of all U.S. coastal wetlands. They are found in coastal states along the Atlantic Ocean and Gulf of Mexico and comprise about 5 million acres. The type of vegetation varies, but usually includes saltmeadow cordgrass, saltgrass, salt-flat grass, annual and perennial glasswort, and sea ox-eye daisy.

Coastal Freshwater or Depressional Wetlands. About 25 million acres in the U.S. are freshwater wetlands. Aquatic vegetation in these wetlands usually depends upon the amount of water available. Spikerush, cattail, and smartweed are common vegetation types.

Riparian Systems. This wetland group includes bottomland hardwood forests, main channels of creeks and rivers and associated wet meadow, bog and beaver pond habitats. Abandoned creek or river channels may continue to hold water and are wetlands called oxbows or resacas. More than 80 million acres of forested wetlands exist in the lower 48 states. The most common species found in these areas are Plains cottonwood, buttonbrush, net-leaf hackberry, native plum, western dogwood, and persimmon.

Prairie Potholes. These are depressional wetlands found in the Upper Midwest, especially in North Dakota, South Dakota, and Minnesota. They are major waterfowl breeding and migration resting areas.

Playa Lakes and Saline Lakes. The playa lakes region of the United States includes portions of Colorado, Kansas, New Mexico, Oklahoma, and Texas. Saline lakes are generally larger than playas, are very saline, and are influenced by ground water. Playas are ephemeral, periodically flooded wetlands. Playas are similar to potholes, but have a different geologic origin. Because they are fed by rainwater, many are dry for extended periods. Playas are the wintering and breeding area for several million ducks, geese, and other migratory birds.

Why are Wetlands Important?

Wetlands are very productive yet fragile ecosystems. They are critical to the survival of a wide variety of plants and animals, including many threatened and endangered species. In fact, nearly 45 percent of all threatened and endangered species in the United States are dependent upon wetlands.

Coastal wetlands are important wintering areas for migratory waterfowl and shorebirds, and breeding grounds for wading birds. The Gulf provides critical habitat for 75 percent of the migratory waterfowl traversing the United States. Nationally, about 80 percent of North America's bird species require bottomland hardwoods to survive. Bottomland hardwood swamps along the Mississippi River alluvial plain and its tributaries provide wintering habitat for up to 30 percent of the North American mallard population and nearly 4 million wood ducks. Wetlands are important for their economic value as well. For example:

- In 1990, U.S. fisheries had a dockside value of \$3.6 billion. Most of the commercially important fish and shellfish in the United States depend upon coastal wetlands and estuaries for spawning, nursery, and feeding grounds. More than 95 percent of the commercial fish caught in the Gulf of Mexico depend heavily on estuarine wetlands.
- The annual value of timber production from southern wetland forests exceeds \$10 billion. More than 80 million acres of U.S. forests are classified as forested wetlands.
- U.S. wetlands provide furs and hides worth over \$400 million each year. Furbearing animals such as nutria, muskrat, mink, raccoon, otter, bobcat, and beaver rely on wetlands for habitat.
- Many farmers and ranchers, especially livestock producers, depend on wetland areas, especially in times of drought, to provide vegetation for haying and grazing.

- Nearly 55 million people spent an estimated \$10 billion observing and photographing waterfowl and other wetland birds in 1980. Many other recreational activities — such as hunting, fishing, boating, and hiking — take place in and around wetlands.

Two of the most important functions of a wetland are controlling streambank/shoreline erosion and flood control. The presence of only 15 percent wetlands in a watershed can reduce overbank flooding of major rivers by as much as 60 percent. The dense wetland vegetation slows down the velocity of water, reducing the severity of flooding. This same vegetation also reduces soil erosion by trapping and holding sediments that would otherwise be washed away into streams and lakes.

Wetlands can also serve as a buffer for severe storms such as hurricanes. Research has shown that for every mile of vegetative wetlands, storm surge height can be reduced by one foot. Hurricane Andrew in 1992 provided an excellent example of the importance of wetlands. Damage to southern Florida, where no wetlands existed, was much more severe than in Louisiana, where a large buffer of coastal marshes separate towns and cities from the Gulf of Mexico.

Wetlands play an increasingly important role in water quality. Sometimes referred to as the "kidneys of the planet," wetlands effectively filter pesticides, heavy metals, and other contaminants from water. They also help in ground water recharge. Constructed or reconstructed wetlands are being used for erosion control and waste treatment with increasing frequency.

Causes of Wetland Loss

Wetland conversion for agriculture and development has historically been the main cause for loss of wetlands. Agricultural conversion has become a minor cause due to legislative restrictions, while development remains high on the list of causes for wetland loss. About half of the population in coastal states lives along the coast and that number increases every year. Construction of dams, canals, levees and dredging operations are other factors that can contribute to loss of wetlands.

But natural causes also affect wetlands. Though wetlands act as a buffer to protect areas against excessive flooding from storms and hurricanes, these events do take a toll. Changes in sea level can cause loss of wetlands.

When delta marshes no longer receive flood-borne sediments, they eventually compact and subside under open water. This can happen naturally, or because of dams upstream that prevent these sediments from reaching the delta. Saltwater intrusion destroys wetlands by killing the plants and converting productive vegetated marshes into less productive open bays.

Wetlands and Agriculture

In the past, wetlands were viewed as too wet for farming, too shallow for swimming and, therefore, generally undesirable. It was easier and more economical to fill them in and cultivate them. Until recently, this activity was encouraged and supported by the federal government. However, the 1985 Farm Bill contained so-called "swampbuster" provisions that eliminated federal financial incentives and technical assistance for conversion of wetland to cropland. Under these provisions, farmers who filled in wetlands forfeited their farm program payments until such time as the land in question was restored to its prior wetland condition.

The legislation also created the Conservation Reserve Program (CRP), which aims to reduce soil erosion, improve water quality, and maintain fish and wildlife habitat by encouraging farmers to enroll highly erodible cropland or land contributing to serious water quality problems into the Reserve for 10 years in exchange for annual rental payments. The 1990 Farm Bill established the Wetlands Reserve Program (WRP) offering landowners payments for restoring and protecting wetlands on their property through 30-year or permanent conservation easements. This program is expected to eventually restore more than 1 million acres of previously converted cropland.

The 1996 Farm Bill gave the Natural Resources Conservation Service the sole responsibility for delineating wetlands on all agricultural land. However, inconsistencies exist between the Farm Bill legislation and wetlands provisions in Section 404 of the Clean Water Act administered by the U.S. Environmental Protection Agency. As the Clean Water Act goes through a reauthorization process, agricultural organizations such as the American Farm Bureau Federation are calling for reform of federal wetlands policy to address such issues as conformity between Section 404 and the "swampbuster" portions of the Farm Bill.

No Net Loss

Today, authorization for a project that will have an adverse effect upon wetlands will not be given unless some sort of mitigation is carried out. Mitigation means to "lessen the impact of". Generally, mitigation takes the form of restoration, creation, replacement, or enhancement of a certain number of acres of wetland. Monetary compensation paid to nature projects can also be a condition of permitting. The federal government's goal is no net loss of wetlands. For each acre of wetland lost to a project, an equal or greater amount of wetland acreage must be added.

Basic Understandings

The following statements taken from the introductory section represent basic understandings that teachers can incorporate into learning objectives for a unit on this subject.

1. The term wetland covers a variety of habitats. Swamps, bogs, coastal and inland marshes, wet meadows, potholes, playas, mudflats, ponds, and bottomland hardwood forests are all types of wetlands.
2. Because of past programs that encouraged the filling-in and development of wetlands, about 54 percent, or 100 million acres, of original wetlands have been lost.
3. Wetlands are important and highly productive ecosystems.
4. Wetlands provide food and clothing products for human use, and also recharge groundwater, process nutrients from polluted waters, provide habitat for wildlife, protect from flooding, and provide recreational activities.
5. Wetlands occur in both freshwater and saltwater systems, and on every continent except Antarctica.
6. Wetlands are transitional zones between aquatic and terrestrial environments.
7. Three things are necessary for an area to be considered a wetland: 1) saturation by ground or surface water for at least part of the growing season, 2) the presence of hydrophilic vegetation, and 3) hydric soils.
8. Wetlands are critical to the survival of a wide variety of plants and animals, including nearly 45 percent of all threatened and endangered species listed in the United States.
9. Each wetland is a little different and not all wetlands have equal value.
10. Nationally, about 80 percent of breeding populations of North American bird species require bottomland hardwoods to survive.
11. Approximately 90 percent of the commercially important fish and shellfish in the United States depend upon coastal wetlands and estuaries for spawning, nursery, or feeding grounds.
12. More than 80 million acres of U.S. forests are classified as forested wetlands. Timber production from them, particularly in southern states, is valued at more than \$10 billion annually.
13. Many recreational activities such as hunting, fishing, and boating take place in wetlands.
14. Furbearing animals such as nutria, muskrat, mink, raccoon, otter, bobcat, and beaver rely on wetlands for habitat. Wetlands provide furs and hides worth over \$400 million each year.
15. In times of drought, wetlands may be the only areas that produce enough haying and grazing for livestock.
16. One of the most important functions of a wetland is streambank/shoreline erosion control and flood control. The presence of only 15 percent wetlands in a watershed can reduce overbank flooding of major rivers by as much as 60 percent.

17. Dense vegetation in wetlands slows down the velocity of water, reducing the severity of flooding.
18. Vegetation reduces soil erosion by trapping and holding sediments that would otherwise be washed away into streams and lakes. Many farmers are now voluntarily placing vegetative buffers and filter strips between production fields and drainage systems in an effort to reduce non-point source pollution.
19. Wetlands can also serve as a buffer for severe storms such as hurricanes and tropical storms. Research done after Hurricane Andrew has shown that for every mile of vegetative wetlands, storm surge height can be reduced by one foot.
20. Wetlands are often referred to as the "kidneys of the planet" because of their effectiveness at filtering out pesticides, heavy metals, and other contaminants from water.
21. Loss of wetlands is due to both natural and human causes.
22. Dams built upriver to divert freshwater, dredging, canals, navigation channels and levees are human activities that contribute to wetland loss.
23. Sea-level rise, subsidence, salt-water intrusion, tropical storms and hurricanes are natural causes of wetland loss.
24. Agricultural conversion and development of wetlands have historically caused most loss of wetlands. Due to legislative restrictions, agricultural conversion is now a minor cause for wetland loss, while increasing development and urbanization, particularly along coastlines, is now the major cause.
25. Prior to 1978, federal farm policies actively encouraged wetland conversions to cropland through both financial and technical assistance.
26. The 1985 Farm Bill contained so-called "swampbuster" provisions. Under these provisions, farmers who filled in wetlands forfeited their farm program payments until such time as the land in question was restored to its prior wetland condition.
27. In order for a development project that has an adverse effect on wetlands to be approved, the federal government requires some form of mitigation so that no net loss of wetlands occurs.

Activity: Making Waves

Some of the important functions of a wetland involve improved water quality, reduction of shoreline erosion, and flood control. Wetlands can improve water quality by filtering out heavy metals and reducing nonpoint source pollution that would otherwise degrade rivers, streams and lakes. Because wetlands slow down and hold water, sediment particles such as sand, silt, clay, and heavy metals can settle out. Excess nutrients in the water are then broken down by bacteria and other microbes and absorbed by plants in a process called nutrient uptake, or returned to the atmosphere by a process called denitrification.

Wetland soils and vegetation act like sponges that have a tremendous ability to absorb excess nitrogen and phosphorous from run-off waters. The vegetation helps to slow down the velocity of water, allowing sediments to settle out. The root systems hold soil in place that would otherwise be carried into streams and rivers. For this reason many farmers are voluntarily planting filter strips and other vegetative buffers between production fields and drainage systems to help reduce pollution from non-point-source pollution.

This water storage capacity can reduce flood damage from storms and hurricanes. Some of the excess floodwater stored in wetlands evaporates, while some may be fed slowly into streams. Still more may seep underground to recharge groundwater. Research has shown that for every mile of vegetated wetland, storm surge from hurricanes can be reduced by one foot.

Materials

2 rectangular cake pans (foil will work)	2-3 lbs. of clay
2 plastic soda bottles	1 indoor/outdoor carpet scrap
water	2 bamboo skewers
tape	sand
topsoil	

Procedure

1. Pile topsoil into the middle of one pan and sand into the other. It should go all the way across the pan and be about 1 1/2 inch below the edge. Smooth it out and slope it downwards toward the back of each pan. The front of the pan should be bare.
2. In the pan with topsoil, sink the piece of carpeting into the top of the mound. It should fit all the way across the pan. This will be the wetland "vegetation". Carefully sprinkle about a handful of topsoil into the carpeting and work it down to the base.
3. Use clay to cover the soil/sand in each pan to create a slightly elevated "lagoon" behind each mound.
4. Cut two pieces of plastic (plastic soda bottles work well) just long enough to go across the pan, and just wide enough to barely clear the bottom of the pan.

Learning Objectives

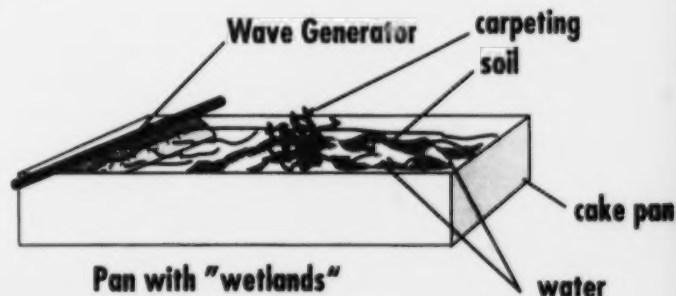
After completing the activity the learner should be able to explain how a wetland:

- Helps to control shoreline erosion.
- Can reduce flood damage from storms.
- Provides a good nursery for aquatic life.

5. Center the bamboo skewers over the bare end of each pan. Tape the pieces of plastic to each of the skewers. These will be used to generate waves.
6. Carefully fill each pan with water. Be sure to saturate each mound of soil, including the carpeting. Be sure you get water into your "lagoon". See diagram below.
7. Place the wave generator into the end of the tray and gently turn it back and forth about once every 5 seconds to create waves washing up on each shoreline. Observe what happens.
8. Now, create as many waves as you can, as quickly as you can. Observe what happens.

Summary Questions

1. Which pan showed the most shoreline erosion? (with "wetlands") (without "wetlands")
2. Which lagoon received the most protection from waves? (with "wetlands") (without "wetlands") Why would this lagoon make a good nursery area for aquatic organisms?
3. Explain how wetland preservation can be a win-win situation for farmers and other land owners, for wildlife and for the general public.



Endangered Species

The United States has more than 700 plants and animals listed as endangered. Another 200 are listed as threatened, and about 3,600 more are suspected of being threatened or endangered. Most people are in favor of protecting endangered species and are even willing to make some sacrifices in order to do so because it allows them to feel they are making a positive contribution to the environment. But few people realize the full impact that endangered species — and the legislation protecting them — can have on their lives.

Why Species Become Threatened or Endangered

The main threat to any species is loss of habitat, which occurs as the result of both natural and human causes. Human activities that can adversely effect the environment and habitat that a particular species depends upon include:

- urban development
- logging
- mineral extraction
- introduction of exotic species
- pollution

While these activities are the result of conscious decisions over which we have some control, other factor are beyond our control. Earth is a dynamic planet that is constantly changing. Wobbling on its axis in its annual trip around the sun, its continents shift, ocean basins open and close, ocean currents alter course, sea levels rise and fall, global weather patterns change, and climates cool down and warm up. Species either adapt to these global changes or they become extinct.

Throughout history, extinction has been the rule rather than the exception. An estimated 90 percent of all the species that have ever lived are extinct. While this should not be used as an excuse to wantonly speed the extinction of any species, neither should it be ignored when making decisions about the future of any of them.

Endangered Species Act

The Endangered Species Act of 1973 was designed to: identify plants and animals threatened with extinction; add them to a list of federally regulated species; devise and implement recovery plans aimed at increasing their numbers to safe and stable levels; and then to remove them from the list.

A species is considered to be endangered if its numbers are so low that it faces extinction within a short period of time. A species is considered threatened if its numbers are rapidly decreasing to a point where it faces the possibility of becoming endangered.

Who decides which species should be labeled as either threatened or endangered? Basically, anyone can request that a species be listed. The U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) are the government agencies responsible for overseeing the protection and recovery of endangered species. These agencies have 90 days to respond to requests. If a request is deemed worthy of consideration, the FWS or NMFS have 12 months from the time of the request to produce the supporting studies, documentation, and background research necessary for listing a species. This timeframe means that, in many cases, rigorous scientific studies cannot be conducted and the FWS or NMFS must use the best available data. Often, the only available data is that which is submitted by the person or organization making the request. This

data may or may not be scientifically accurate and unbiased. Consequently, millions of tax dollars have been spent on listing species that were not in imminent danger of extinction.

What is Protected?

When thinking of endangered species, the tendency is to think of large animals such as the humpback whale, manatees, bald eagles, California condors, or whooping cranes. And yet, more than 70 percent of the animals currently being considered for listing are invertebrates such as snails, spiders, and insects.

The Endangered Species Act makes no distinction between a true species and those that are merely a subspecies, or population segment. As a result, the number of threatened and endangered species is misleadingly high. For example, the northern spotted owl and the Florida panther are listed as endangered species. The northern spotted owl belongs to the same species as the California spotted owl and the Mexican spotted owl, which are not endangered. The Florida panther is merely an eastern version of the panthers (also called cougars, mountain lions, or pumas) found elsewhere in the western United States. This lack of distinction between truly endangered species and subgroups of the species has generated controversy in recent years.

In many cases, a species is listed as endangered simply because a particular part of the United States is at the extreme limit of its range and, therefore, the species is peripheral or uncommon in the United States. That these species are common elsewhere is not taken into consideration. For example, gray wolves are rather rare in the United States, but they are quite common in Canada. Likewise, the southwestern United States is the extreme northern range of the ocelot, which is much more common in South America.

Habitat Protection and Private Property

The Endangered Species Act prohibits anyone from harming an endangered species by harassing, hunting, chasing, trapping, shooting, wounding, killing, collecting, or engaging in any other harmful activities. The Act also requires a critical habitat to be defined that is considered necessary to the recovery of a species to the point where it can be removed from the list. Modification or degradation of habitat that might constitute harm to a species is not allowed.

Within reasonable limits, people assume they are entitled to do what they want on their own land. This is, after all, what the Fifth Amendment of the Constitution is about. The reality is that, under the Endangered Species Act, some landowners are unable to use their property for activities such as farming, ranching, or forestry, even if they have already been doing so for many years. Ironically, these very activities by the landowner may have attracted the species to the land in the first place. But once an endangered species is established on a piece of property, these activities become illegal.

On private land, the Endangered Species Act treats plants differently from animals. Plants are considered part of the real estate on which they grow and, as such, are legally part of private property. Animals, including all invertebrates, are part of the public trust and not private property. Despite this distinction, it is the property owners who bear the financial burden when it comes to providing habitat for any endangered species found on their land.

If private property is taken for public projects, such as through the process of condemnation, the landowner is compensated and paid a fair-market price for the property. This does not happen in the case of land rendered essentially unusable by the Endangered Species Act. The landowner receives no compensation for the loss of land value, even if the owner makes his or her living from this land.

Definitive proof of the presence of an endangered species on a particular property is not required before designating it as critical habitat. The burden of proof that land is not critical habitat, or that the endangered species is not present, rests with the landowner. And, although they retain title to their land, landowners may end up losing possession due to the land use restrictions and economic constraints placed upon them.

Critical habitat is increasingly being used by special-interest groups as a reason to halt development of unwanted projects. The actual presence of an endangered species in the targeted area is not always the primary concern.

Impacts of the Endangered Species Act

Since the Endangered Species Act was enacted, species have been added to the list and very few have been removed. Some species were removed because inadequate data resulted in underestimation of their range, including the tumamoc globeberry in Arizona, the barbate June beetle in California, and the pine barrens tree frog in Florida. The Mexican duck was determined to be just a variation of the common mallard. While these species were listed, millions of dollars were spent that could have been used to protect species that truly are endangered.

Very few species have critical habitat solely on public lands. The U.S. Fisheries & Wildlife Service reports that 78 percent of endangered species can be found on private property. People in various areas of the United States have found themselves in conflict with the Endangered Species Act. For example:

- Twenty-nine homeowners in southern California needlessly lost their homes to wildfire because the presence of the endangered Stephens kangaroo rat in the area prevented them from complying with a county ordinance requiring a fire break. The several homeowners who ignored the ESA ruling did not lose their homes to the fire.
- Property owners in Texas and Florida have been unable to build homes on land they already own because of the potential use of

that land by endangered birds. In both cases the birds were not actually present on the property.

- In California, Texas, Florida, Arizona, Utah, and Colorado, landowners whose families have been farming the same land for 50 years or longer were threatened with lawsuits and told they could not do routine plowing and clearing because these activities are disruptive to endangered species that potentially could be on their land.

Agriculture and Habitat

America's farmers and ranchers have traditionally provided most of the nation's wildlife habitat. Wildlife is a source of income from hunting and nature-centered activities such as birding and, in many cases, not much is required to provide good wildlife habitat. In the open plains, the presence of fence posts to provide a lookout for raptors is all that is needed for these birds to move in. Fence lines make excellent habitat for insects, small birds and mammals, and provide a source of food for the raptors. Wetlands can provide forage and pasture for livestock while also providing habitat for migrating waterfowl.

Through voluntary state, federal, and private conservation programs, landowners can set aside land for wildlife habitat enhancement.

- The *Conservation Reserve Program* allows landowners to enroll highly erodible land, or land contributing to a serious water quality problem, into the program for a period of ten years in exchange for annual rental payments, cost-sharing, and technical assistance to plant vegetation for conservation.
- The *Wetland Reserve Program* allows landowners to receive payments and technical assistance for wetland restoration in exchange for 30-year or permanent conservation easements of these lands. While these programs are not aimed specifically at endangered species, these species have nonetheless benefited.
- *Habitat Conservation Plans* offer another way for different interests to collaborate on providing habitat for endangered species while, at the same time, developing land within the habitat area. Participants agree to mitigate impacts, set aside habitat elsewhere in exchange for developing the land, and abide by certain land use restrictions within the HCP area.
- *Safe Harbor Agreements* encourage private landowners to enhance habitat in areas that could potentially attract endangered species. Most landowners want to improve habitat on their land anyway, and these agreements allow them to do so without incurring liability. These agreements are successfully operating in South Carolina and in parts of North Carolina and Texas. Three steps are involved:
 1. The U.S. Fish & Wildlife Service conducts an inventory of the property.

2. The private landowner agrees to manage the property for the baseline inventory.
3. If an increase in a target species occurs, the landowner is not penalized.

Even if they are not involved in a program designed to enhance wildlife habitat, many farmers and ranchers voluntarily set aside and plant acreage specifically to provide food and cover for wildlife. They receive no monetary compensation for doing so. They do it merely because of the personal satisfaction received.

Reforming the Endangered Species Act

The Endangered Species Act expired in 1992, but Congress continues to fund it and so it has the force of law. Still, the controversies surrounding it since enactment have led to calls for reform. Most people do not mind large sums of money being spent on what is referred to as "charismatic megafauna"—the popular species like bald eagles, manatees, and seals. But the public is having an increasingly hard time with large sums being spent on snails, slugs, flies, and spiders while the needs of people are ignored and their livelihoods are threatened. We may be reaching a point where we will have to make choices on which species merit the most attention and funding, because we simply cannot afford to save all of them.

Sound scientific studies subject to peer review need to be done to determine the status of each species before it is listed. Recovery plans need to take economic factors into consideration. Landowners should be given tax concessions or other financial compensation when their property use is restricted because of endangered species. We need to make the presence of a thriving population of an endangered species on a landowner's property a source of pride rather than a liability by offering incentives such as conservation contracts. With these kinds of reforms, the Endangered Species Act could indeed be a positive situation for both people and the wildlife it is meant to protect.

Basic Understandings

1. More than 700 plants and animals are listed as endangered in the United States. Another 200 are listed as threatened, and about 3,600 others are suspected of being either threatened or endangered.
2. The main threat to any species is loss of habitat, which can be from either natural or human causes.
3. Human causes for loss of habitat include urban development, logging, mineral extraction, agriculture, the introduction of exotic species, pollution, and other types of human activities.
4. Natural causes for loss of habitat include rise and fall of sea-level, changes in ocean currents, changes in global weather patterns, and global climate change.

5. More than 90 percent of all the species that have ever existed are now extinct. Extinction is the rule rather than the exception.
6. The Endangered Species Act, enacted in 1973, was designed to identify plants and animals threatened with extinction, add them to a list of federally regulated species, devise and implement recovery Plans aimed at increasing their numbers to safe and stable levels, and then remove them from the list.
7. A species is considered to be endangered if its numbers are so low that it faces the possibility of extinction within a short period of time.
8. A species is considered threatened if its numbers are rapidly decreasing to a point where it faces the possibility of becoming endangered.
9. The U.S. Fish and Wildlife Service and the National Marine Fisheries Service are the two federal government agencies responsible for overseeing the protection and recovery of endangered species.
10. Anyone can request that a species be listed as threatened or endangered. The FWS or NMFS have 90 days to respond to the request.
11. Because good scientific studies are often lacking, species are listed that may be neither threatened nor endangered. Millions of dollars are spent in an attempt to qualify these species for removal from the list.
12. More than 70 percent of the animals currently being considered for listing are invertebrates such as snails, spiders, and insects.
13. Many "species" that the act protects are really subspecies or population segments, not true species. This makes the number of endangered species misleadingly high.
14. Because no distinction is made on how common a species is in other parts of the world, certain species will never be removed from the list because the parts of the United States in which they live are at the extreme limit of their range.
15. Critical habitat is that habitat considered critical if the species is to be recovered to numbers sufficient to remove it from the list.
16. Attempting to harass, hunt, chase, trap, shoot, wound, kill, collect, or otherwise harm listed species is forbidden by the Endangered Species Act.
17. Because of the ESA, some farmers, ranchers, and other private property owners have been told they may no longer engage in the normal and legal activities allowed on private property.
18. The Fifth Amendment of the Constitution protects private property rights. When private property is taken for public projects, the landowner is compensated at fair-market prices. Owners of land rendered useless by the ESA, however, are not compensated for the loss of value.
19. A species does not necessarily have to be present on designated land for it to be considered critical habitat.
20. Critical habitat is increasingly being used by special interest groups as a reason to halt the development of projects in a particular area. The actual presence of an endangered species is often not the primary concern.
21. Paying for studies required under the ESA to prove that a species is not on certain property is expensive and beyond the means of most landowners.
22. Since the ESA was enacted in 1973, species have been added to the list but few have been removed. The only species removed were extinct, on the list by mistake, or probably owed their recovery to other factors.
23. Nearly 80 percent of U.S. wildlife habitat is on private land; farmers and ranchers have traditionally provided the majority of wildlife habitat.
24. Wildlife is a source of income to many farmers and ranchers, so it is in their best interests to practice good stewardship and provide the best possible habitat for wildlife.
25. Without the use of high intensity, high productivity farming, much of the marginal farm land now being set aside for wildlife would have to be cultivated to feed the human population.
26. Voluntary initiatives such as the Conservation Reserve Program and the Wetlands Reserve Program allow landowners to receive technical assistance and other benefits in exchange for managing and enhancing their land for wildlife.
27. Habitat Conservation Plans bring different interests together to collaborate on ways to provide habitat for endangered species and, at the same time, allow land development within the habitat area.
28. The Endangered Species Act expired in 1992, but Congress continues to fund it and it has the force of law.
29. A number of people believe we are reaching a point where we will have to make choices about which species to save because we cannot afford to save them all.
30. Reforms of the Endangered Species Act should include more voluntary conservation programs, compensation for landowners who lose the use of their property, peer-reviewed scientific studies, and recovery plans that take economic factors into account, as well as legal status and protection for individuals who challenge ESA findings.

Activity: Food Fight!

A good habitat provides food, water, shelter, and a certain range of temperature and climate. Some species also require a lot of space, or territory. Taking away any one of these conditions reduces the quality of the habitat. If other places can more completely meet the organism's needs, it probably will move into that area. If not, and the organism cannot adjust to changes in the existing environment, it faces the possibility of extinction.

Some changes in an organism's habitat are man-made, like urban development, logging, mineral extraction, agriculture, fishing, pollution, and the introduction of exotic species. Other changes are natural, such as shifts in climate, sea level, or ocean currents.

Materials

1 package of large, thick rubber bands	1 large box of paper clips
1 package of marbles	100 pennies
plastic spoons	5 oz paper cups (1 per person)
1 large piece of chart paper or poster board	clothes pins
	1 sheet, blanket, or tablecloth
	1 pad of small sticky notes

Procedure

1. Spread the sheet, blanket or tablecloth on the floor to represent the "feeding ground".
2. Completely cover the sheet with the pennies, marbles, rubber bands and paper clips. These represent items that potentially could be used as food.
3. Give each person a paper cup, representing a "stomach".
4. Divide the group into two smaller groups. Give each member of one group a plastic spoon. Give each member of the other group a clothespin. These are the tools each person will use to gather the food needed to survive.
5. Participants with clothespins may only "eat" rubber bands. Participants with spoons may "eat" any of the items.
6. At the signal, participants are to gather as many food items into their "stomachs" as they can in 30 seconds. The following rules apply:
 - A. Only one food item at a time may be picked up, and only with the implement received.
 - B. Food must be brought to the stomach; the stomach can not be used to help pick up food.
 - C. Only one hand can be used to pick up food items.
 - D. Participants must return to the edge of the "feeding ground" for the start and end of each round.

Learning Objectives

After completing the activity the learner should be able to explain:

- Characteristics of a good habitat.
- Reasons a species may not always be able to use available resources.
- Ways in which endangered species co-exist with people to the benefit of both.

Results

1. Once time has been called, count up the number of items you have in your cup. For each five items you collected, take one sticky note (round up to the nearest 5).
2. On the large sheet of chart paper, use the sticky notes to make a bar graph to record how well each "species" did.
3. Since it takes ten rubber bands for the "clothespin species" to survive and reproduce, anyone who did not collect ten rubber bands is now considered "dead" and sits out the remaining rounds.
4. The "spoon species" also requires ten food items to survive and reproduce. Anyone who did not collect ten food items is considered "dead" and sits out the remaining rounds.
5. Repeat the rounds until either one species is "extinct", or no food items are left.

Summary Questions

1. Which species did the best overall? (the "spoon species" or the "clothespin species")
2. Which food item was collected the least? (pennies, marbles, rubber bands, paper clips)
3. As more and more of the rubber bands were "eaten", what happened to the feeding success of the "clothespin species"? (declined, stayed the same, increased)
4. What do you think would have happened if the "spoon species" was unable to "eat" rubber bands?
5. Suggest several positive ways you could encourage people to save the "clothespin species" from extinction.

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